

On the Electricity of Rain and Its Origin in Thunderstorms

George C. Simpson

Proc. R. Soc. Lond. A 1909 **82**, 169-172

doi: 10.1098/rspa.1909.0020

Email alerting service

Receive free email alerts when new articles cite this article - sign up in the box at the top right-hand corner of the article or click [here](#)

To subscribe to *Proc. R. Soc. Lond. A* go to: <http://rspa.royalsocietypublishing.org/subscriptions>

On Electricity of Rain and its Origin in Thunderstorms. 169

rate of evolution in this case was only 0·0127, about one-fifth of that observed with the previous sample.

The majority of minerals allow water to percolate through them. The effective superficial area must therefore much exceed the external surface.

It is probable that loss of helium occurs from the weathering of these interior surfaces as well as from the external faces of the crystals. Abrasion of the external surfaces by comparatively recent rolling in water-courses may have produced some effect.

Under laboratory conditions the rate of escape of helium from minerals always far exceeds the rate of production by radio-active change. Therefore the conditions under which the life of the minerals has been mainly passed, deep down in the earth, where atmospheric agencies have no place, must be supposed more favourable to retention of helium, for otherwise the present accumulation could never have been formed. The observations here recorded leave little room for surprise that fossilised bones and other materials do not always contain as much helium as would be expected from their radio-activity and geological age.

On the Electricity of Rain and its Origin in Thunderstorms.

By GEORGE C. SIMPSON, D.Sc.

(Communicated by Dr. Gilbert T. Walker, F.R.S. Received January 6,—Read February 4, 1909.)

(Abstract.)

During 1907–08 an investigation was undertaken at the Meteorological Office of the Government of India, Simla, into the electrical phenomena which accompany rain and thunderstorms.

Two lines of research were adopted :—

(a) A systematic record was obtained by means of self-registering instruments of the electricity brought down by the rain throughout one rainy season.

(b) Laboratory experiments were made with the object of determining the source of the electricity of thunderstorms.

The chief results of the first part of the work may be briefly summarised as follows :—

(1) The aggregate amount of rain which fell during the periods of rainfall investigated was 76.3 cm.

(2) The total quantity of positive electricity which fell on each square centimetre of surface was 22.3 electrostatic units, and of negative electricity 7.6 units; thus 75 per cent. of the electricity brought down by the rain was positive.

(3) During 71 per cent. of the time that charged rain fell the charge was positive.

(4) Considering that falling rain carrying a positive charge is equivalent to a positive current, and rain with a negative charge to a negative current, then positive currents greater than 300×10^{-15} ampere per square centimetre were measured in six storms and negative currents greater than 300×10^{-15} ampere per square centimetre were measured in two storms.

(5) In seven storms rain was recorded carrying greater positive charges than 6 electrostatic units per cubic centimetre of water, and in two storms a greater negative charge than this amount occurred.

(6) The heavier the rainfall the more the positively charged rain preponderated over the negatively charged rain; and all rainfall which occurred at a greater rate than a millimetre in two minutes was positively charged.

(7) Light rain was more highly charged than heavy rain.

(8) The proportion of negative electricity brought down by the rain was slightly greater in the second than in the first half of the storms.

(9) The potential gradient was more often negative than positive during rain.

(10) No relationship between the sign of the potential gradient and the sign of the electricity of the rain could be detected.

The laboratory experiments showed that when a large drop of water is broken up into small drops in the air the water becomes positively and the air negatively charged.

In the first series of experiments drops of water, each having a volume of 0.24 c.c., fell on to a vertical jet of air which broke them up into small drops. It was found that under these circumstances the water of each drop, after having been broken up on the jet, carried a charge of 5.2×10^{-3} electrostatic unit of positive electricity. Further, it was found that the presence of an original charge on the drops did not alter the effect. Drops originally charged positively had their charges increased and drops charged negatively had their charges decreased.

In the second series of experiments water was introduced through two small tubes into a vertical current of air which carried the water upwards. Part of the water which escaped from the air current was caught in an

1909.]

Rain and its Origin in Thunderstorms.

171

insulated vessel and was found to be positively charged, the charge being 15×10^{-3} electrostatic unit per cubic centimetre of water.

In the third series of experiments drops of water were broken up in a similar manner to that employed in the first series, but within a compartment from which the air could be drawn through an Ebert apparatus. The result showed that the breaking of the drops caused an ionisation of the air. The breaking of each drop released 3.3×10^{-3} electrostatic unit of free negative ions and 1.1×10^{-3} electrostatic unit of free positive ions; the excess of negative ions corresponds to the positive charge retained by the water.

In 1904 Prof. Lenard* showed that drops of water having a greater diameter than 5.5 mm. are unstable when falling through air and rapidly break up into smaller drops. He also showed that all drops having a smaller diameter than 5.5 mm. have a final velocity when falling through still air of less than 8 metres a second. Thus no water can fall through an ascending current of air having a velocity of 8 metres a second; for all drops less than 5.5 mm. in diameter are carried upwards, and all drops having a larger diameter quickly break up into smaller drops. These facts, together with the results of the observations and experiments described above, have led to the formation of the following theory for the origin of the electricity of thunderstorms.

It is exceedingly probable that in all thunderstorms ascending currents greater than 8 metres a second occur. Such currents are the source of large amounts of water which cannot fall through the ascending air. Hence, at the top of the current, where the vertical velocity is reduced on account of the lateral motion of the air, there will be an accumulation of water. This water will be in the form of drops which are continually going through the process of growing from small drops into drops large enough to be broken. Every time a drop breaks a separation of electricity takes place, the water receives a positive charge, and the air a corresponding amount of negative ions. The air carries away the negative ions, but leaves the positively charged water behind.

A given mass of water may be broken up many times before it falls, and in consequence may obtain a high positive charge. When this water finally reaches the ground it is recognised as positively charged rain. The ions which travel along with the air are rapidly absorbed by the cloud particles, and in time the cloud itself may become highly charged with negative electricity. Now within a highly electrified cloud there must be

* Lenard, 'Met. Zeit.,' vol. 21, p. 249, 1904.

rapid combination of the water drops, and from it considerable rain will fall; this rain will be negatively charged, and under suitable conditions both the charges on the rain and the rate of rainfall could be large.

A rough quantitative analysis shows that the order of magnitude of the electrical separation which accompanies the breaking of a drop is sufficient to account for the electrical effects observed in the most violent thunderstorms. All the results of the observations of the electricity of rain described above are capable of explanation by the theory, which also agrees well with the actual meteorological phenomena observed during thunderstorms.

The Tension of Metallic Films deposited by Electrolysis.

By G. GERALD STONEY.

(Communicated by the Hon. C. A. Parsons, C.B., V.-P.R.S. Received January 16,
—Read February 4, 1909.)

It is well known that metallic films deposited electrolytically are in many cases liable to peel off if deposited to any considerable thickness. This is the case with nickel which, when deposited over a certain thickness, will curl up into beautiful close rolls, especially if it does not adhere very tightly to the body on which it is deposited. For example, if a piece of glass is silvered by any of the usual silvering solutions, and then nickel is deposited on the silver, it is found that the nickel and silver peel off the glass in close tight rolls almost at once. In 'Practical Electro-Chemistry,' by Bertram Blount, reference is made on pp. 114 and 272 to the tendency of nickel to peel off, and it is stated that it "will peel—spontaneously and without assignable cause" (p. 272), but that a thick coating can be obtained by keeping the solution at between 50° and 90° C.

The late Earl of Rosse* tried, about 1865, to make flat mirrors by coating glass with silver chemically, and then electroplating with copper; but he found that, owing to the "contraction" of the copper film, it became detached from the glass. I have had the same experience in protecting silver films in searchlight reflectors by a film of electro-deposited copper, it being found that if the film of copper is more than 0.01 mm. thick peeling is apt to take place.

Dr. Gore, F.R.S., in papers in the 'Phil. Trans.,' in 1858 and 1862, found

* 'Nature,' Aug. 20, 1908, p. 366.